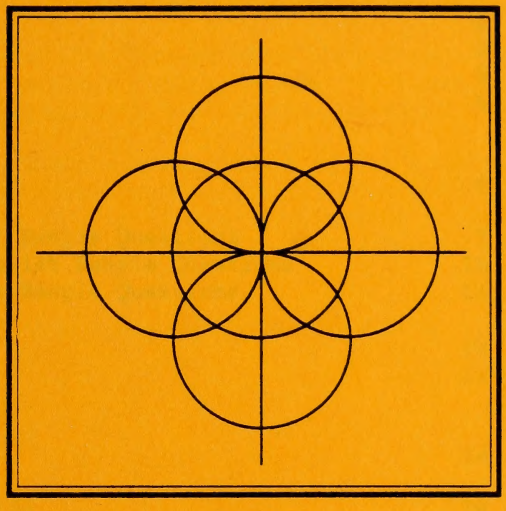
Student Achievement Testing Program Bulletin

Grade 6 Mathematics



1990-91 School Year

Students First !

Student Evaluation

Alberta EDUCATION

September 1990

This bulletin contains general information about the 1991 Student Achievement Testing Program and specific information about the Grade 6 Mathematics Achievement Test. Additional copies of this bulletin may be obtained by telephoning Alberta Education at 427-2948.

DISTRIBUTION: Superintendents of Schools • School Principals and Teachers • The Alberta Teachers' Association • Alberta School Trustees' Association • Officials of Alberta Education • General Public Upon Request

September 1990

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GENERAL INFORMATION

The Achievement Testing Program provides Alberta Education, school jurisdictions, and the public with information significant at the provincial and local levels about what students know and can do in relation to the objectives. It does not provide information to be used for student placement or promotion.

The achievement tests are administered on a four-year cycle in four subject areas: language arts, social studies, mathematics, and science; and at the three grade levels: 3, 6, and 9.

The achievement tests are specific to the *Program of Studies* prescribed by the Minister of Education. Classroom teachers from across the province are extensively involved in developing and field testing the questions.

Information pertaining to the nature and administration of the Achievement Testing Program, exemptions, and students receiving instruction in French, can be found in the *Achievement Testing Program General Information Bulletin, 1990-91*, which is being mailed to all superintendents and principals.

During 1991, the achievement tests will be administered according to the following schedule:

Tuesday - June 11, 1991

Grade 3 Science (a.m.)

Grade 6 Mathematics* (a.m.)

Grade 9 Social Studies* (a.m.)

* A French translation of this test is available and must be administered at the same time as the English test. Schools will be sent enrolment forms from Alberta Education by February 1991 requesting an indication of which test versions are required (English/French). These forms must be returned through jurisdiction offices by March 8, 1991.

Reporting Achievement Test Results

In October 1991, a provincial report will be issued that will present the overall results for the province on major curriculum dimensions. Each jurisdiction will receive a district profile of student achievement to parallel the provincial report, as well as guidelines for interpreting the jurisdictional results in relation to provincial standards. School jurisdictions and schools will receive reports based only on their students. Provincial results will be released publicly through the annual *Achievement Testing Program Provincial Report*.

DESCRIPTION OF THE GRADE 6 MATHEMATICS ACHIEVEMENT TEST

General Description

The 1991 test is made up of two sections. Section 1 consists of the Calculator Booklet and the Non-Calculator Booklet, which contain 55 questions covering the five mathematics strands and the problem-solving strategies. Section 2 consists of the Timed-Tests Booklet containing five timed tests in addition, subtraction, multiplication, division, and mixed operations. Each timed test has 48 questions.

Unlike the 1987 test, this test provides for the optional use of calculators. Calculators will be allowed for the Calculator Booklet only.

Test Section	Time allowed
Section 1	
Calculator Booklet: - calculators are optional	45 minutes
Non-Calculator Booklet: - calculators are not allowed	25 minutes
REST BREAK	
Section 2	
Timed-Test Booklet	2 minutes for each of five tests

The 1991 mathematics achievement test will have at least one "cluster" item where two or more questions are generated from the same data. (See the example on page 7.)

All questions are multiple-choice with four alternatives.

Section 1: Students will answer questions on machine-scorable answer sheets.

Section 2: Students will answer questions in the test booklet by filling in the small circle beside the correct response.

Students will require HB pencils, erasers, and scrap paper.

Use of Calculators

A word on calculators. There are two ways of choosing calculators:

(1) Choose a four-function calculator and emphasize order of operations throughout the teaching methodology.

(2) Choose a scientific calculator and only use a few of the keys. The number of keys used increases as the student's mathematical ability increases. The choice is up to the teacher, and either will be allowed.

To illustrate this, let us consider the example: 7 + 3 x 5 =

With a four-function calculator, there are two methods:

(1) Use the memories:

7 (M+)

3 (x) 5 = (M+)

(MR)

(2) Rewrite problem so that multiplications are done first:

3 x 5 + 7 =

With a scientific calculator, the operating system of the calculator takes care of the order of operations and the calculation is entered as written. Either the use of a four-function calculator with memory or the use of the scientific calculator would be recommended.

Articles Supporting Calculator Use on Mathematics Tests:

Calculators on the Exit Level Teams Test, A position paper prepared by the Texas Association of Supervisors of Mathematics, Newsletter, The National Council of Supervisors of Mathematics, Vol. XIX, No. 1, (October 1989).

This organization is supporting the April 1986 NCTM recommendation to integrate the calculator into the school mathematics program at all levels in class work, homework, and evaluation. When calculators cannot be used on standardized tests, teachers cite this as a reason for not using calculators in the classroom.

Chambers, Donald L., *"Calculating the Influence of Tests on Instruction,"* *Arithmetic Teacher*, Vol. 36, No. 9, (May 1989), pp. 10-11.

Suggests that all state, college, commercial, and locally developed tests be designed to be completed using calculators.

Guidelines for the use of Calculators Grades 1-12, Alberta Education, 1981.

Encourages the use of calculators throughout grades 1 to 12. Contains a *Policy Statement on the Use of Calculators on Alberta Education Examinations*, found in Appendix E.

Continued

Heid, M. Kathleen, *"Calculators on Tests - One Giant Step for Mathematics Education,"* Mathematics Teacher, Vol. 81, No. 9, (December 1988), pp. 710-713.

If the use of calculators on tests has the potential for opening the door to future mathematics, then the current issues must be resolved. Many of the beliefs such as economic advantage and inability to do computations are dealt with. The bottom line is that we must start preparing students for the future and not hold them in our past.

Hembree, Ray, *"Research Gives Calculators a Green Light,"* Arithmetic Teacher, Vol. 34, No. 1, (September 1986), pp. 18-21.

Reviewing 79 reports on the use of calculators resulted in the author making the following statement: "Students in grades five and above should be permitted to use calculators in all problem-solving activities, including testing situations."

Lewis, Janice & Hoover, H. D., *"The Effect on Pupil Performance of Using Hand-Held Calculators on Standardized Mathematics Achievement Tests."* Paper presented at the Annual Meeting of the National Council on Measurement in Education (Los Angeles, California: April 1981).

In a study on eighth grade students, it was found that if the tests used in mathematics were standardized with calculators, the rankings of students would be the same as the rankings given by present mathematics subtests without calculators.

Content of the Test

Section 1

Test questions, based on the *Grade 6 Mathematics Curriculum Specifications* (Revised, May 1986), are limited to curriculum objectives that may be effectively measured with paper and pencil tests. The psychomotor and attitude components of the Grade 6 Mathematics program are not assessed. This test blueprint reflects the weighting proportioned to the subject matter and problem solving components.

Blueprint for the Grade 6 Mathematics Achievement Test, Section 1

Content	Subject Matter by Cognitive Levels and Number of Questions*			Problem Solving	Total Number of Questions
	Knowledge	Comprehension	Application		
Numeration	6	3	2	2	13
Operations and Properties	1	9	4	2	16
Measurement	4	2	3	2	11
Geometry	2	2	1	1	6
Graphing		2	3	1	6
Problem-Solving Strategies	-0-	-0-	-0-	3	3
Total Number of Questions	13	18	13	11	55

***See page 13 for explanation of taxonomy terms**

Section 2

The five timed tests measure students' speed and accuracy in doing sums and minuends to 18, and products and dividends to 81. To measure students' speed and accuracy, it is essential that students answer questions in the correct sequence. The layout of the timed tests has been designed to facilitate this.

Operations	No. of Questions	Time in Minutes
Addition	48	2
Subtraction	48	2
Multiplication	48	2
Division	48	2
Mixed Operations	48	2

Two conventions will be used on the test:

6 + 3 =	6 - 3 =	6 x 3 =	6 ÷ 3 =
6	6	6	
+ 3	- 3	x 3	3) 6

Confirming Standards

Confirming standards is a process whereby teachers are asked to make judgments related to the achievement test to answer the question of whether province wide performance is satisfactory. For more information on confirming-standards procedures, refer to Appendix C of the *Achievement Testing Program Provincial Report, June 1990 Administration*. For information on the selection of teachers for participation in the confirming-standards process, refer to the *Achievement Testing Program General Information Bulletin, 1990-91*.

SAMPLE QUESTIONS

Sample questions that reflect the nature and complexity of the questions that will appear on the 1991 test are presented on the following pages.

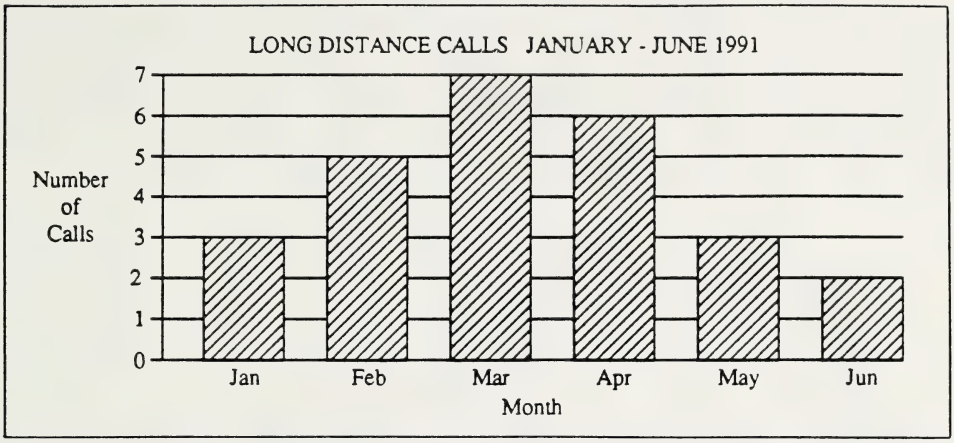
Teachers are encouraged to familiarize their students with the types of questions that will appear on the achievement test by having them work through the sample questions. Please note that this collection of questions does not represent the test emphasis as presented in the blueprint.

Questions 1 and 2 are "cluster" or "family" questions. Questions 3 to 8 are discrete questions.

The difficulty level of the question, which indicates the percentage of students who answered the question correctly on field tests, is also given. For example, a difficulty level of 0.431 means that 43.1% of the students answered the question correctly.

Section 1: Calculator Booklet Sample Questions

Use the following information to answer questions 1 and 2



1. According to the graph, the number of long-distance calls in May and June combined was equal to the number of calls in

   A. January
   *B. February
   C. March
   D. April

Program Element: Subject Matter, graphing - interprets and solves problems using a bar graph
Cognitive Level: Application
Difficulty: 0.772

In this question, students are to interpret a bar graph and choose the correct mathematical operation to solve a problem.

2. The number of phone calls in December is 12. What is the ratio of the number of long-distance calls in January to the number of long distance calls in December?

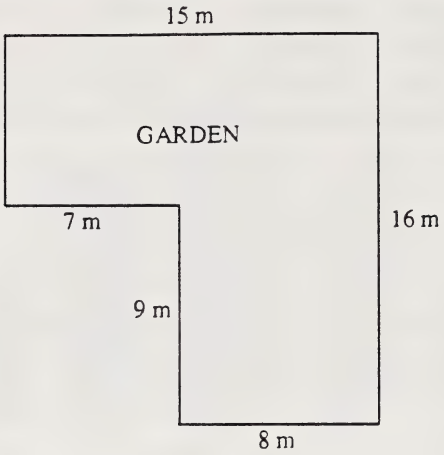
   A. 1:3
   *B. 1:4
   C. 3:4
   D. 4:1

Program Element: Subject Matter, numeration - identifies and uses proportional ratios
Cognitive Level: Application
Difficulty: 0.708

In this question, students are to understand ratio and apply it to information interpreted from a graph.

* Denotes correct answer

3. Mr. King has a garden as shown in the diagram.



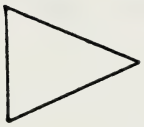
He wants to put a wire mesh fence around his garden. What would be the total length of the fence?

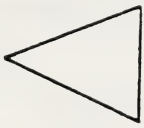
A. 46 m
B. 52 m
C. 55 m
*D. 62 m

Program Element: Problem-Solving Skills and Strategies using measurement
Cognitive Level: Problem Solving
Difficulty: 0.451

In this question, students are required to identify the missing length and add it to the given lengths to find the perimeter.

4. Which figure is a slide image of the figure at the right?

A. 

B. 

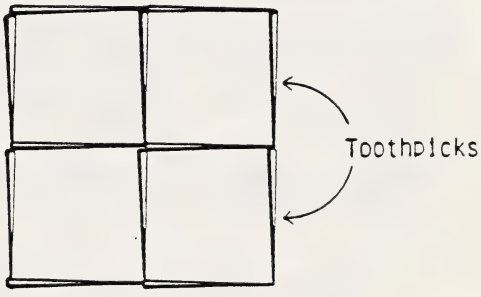
C. 

*D. 

Program Element: Subject Matter, geometry - identifies a slide
Cognitive Level: Knowledge
Difficulty: 0.685

In this question, students are to identify a slide image which matches the given image.

5. A farmer has four pens for his pigs. He needs only two pens. The model of the four pens is shown at the right.



What is the LEAST number of toothpicks you must remove to get two pens?

*A. 2
B. 3
C. 4
D. 5

Program Element: Problem-Solving Skills and Strategies outside the curriculum content
Cognitive Level: Problem Solving
Difficulty: 0.526

In this question, students are required to use strategies to find the least number of toothpicks that can be removed to change 4 areas into 2.

6. Carol correctly answered 6 out of 8 questions. What was her score in percent?

   A. 48%
   B. 68%
   C. 70%
   *D. 75%

Program Element: Subject Matter, numeration - expresses fractions as per cents
Cognitive Level: Application
Difficulty: 0.671

In this question, students are required to convert 6/8 to a percent.

7. Find the product.

$$\begin{array}{r} 3.23 \\ \times\ 0.9 \\ \hline \end{array}$$

   A. 2.787
   *B. 2.907
   C. 27.87
   D. 29.07

Program Element: Subject Matter, operations and properties - multiplies decimals using one-, two-, and three- digit multipliers
Cognitive Level: Comprehension
Difficulty: 0.762

In this question, students are required to multiply decimal numbers and put decimals in the correct place in the answer.

8. Bonnie sold 21 boxes of chocolate bars. Each box contained 48 chocolate bars. The best estimate of the total number of chocolate bars she sold is

   A. 69
   B. 500
   C. 800
   *D. 1000

Program Element: Subject Matter, operations and properties - estimates products
Cognitive Level: Application
Difficulty: 0.766

In this question, students are required to estimate the product of two digit numbers.

ADDITION

1.	2.	3.	4.
2+7= ○ 5 ○ 9 ○ 10 ○ 14	8+6= ○ 2 ○ 14 ○ 15 ○ 48	6+7= ○ 1 ○ 11 ○ 13 ○ 42	9+3= ○ 12 ○ 13 ○ 14 ○ 27
5.	**6.**	**7.**	**8.**
3 + 3 ○ 0 ○ 3 ○ 6 ○ 9	7 + 9 ○ 14 ○ 15 ○ 16 ○ 17	8 + 9 ○ 1 ○ 17 ○ 18 ○ 19	7 + 6 ○ 1 ○ 13 ○ 14 ○ 42

SUBTRACTION

9.	10.	11.	12.
7-3= ○ 3 ○ 4 ○ 10 ○ 21	16-9= ○ 6 ○ 7 ○ 9 ○ 25	12-5= ○ 3 ○ 4 ○ 7 ○ 13	10-3= ○ 3 ○ 6 ○ 7 ○ 13
13.	**14.**	**15.**	**16.**
15 - 6 ○ 1 ○ 8 ○ 9 ○ 21	3 - 0 ○ 0 ○ 1 ○ 2 ○ 3	11 - 8 ○ 2 ○ 3 ○ 4 ○ 17	9 - 7 ○ 2 ○ 3 ○ 7 ○ 16

MULTIPLICATION

17.	18.	19.	20.
7x5= ○ 2 ○ 12 ○ 35 ○ 40	9x2= ○ 7 ○ 11 ○ 18 ○ 29	3x5= ○ 8 ○ 15 ○ 25 ○ 35	9x7= ○ 63 ○ 64 ○ 69 ○ 79
21.	**22.**	**23.**	**24.**
8 x 6 ○ 14 ○ 34 ○ 48 ○ 68	5 x 6 ○ 1 ○ 11 ○ 25 ○ 30	7 x 0 ○ 0 ○ 7 ○ 17 ○ 70	9 x 6 ○ 15 ○ 54 ○ 56 ○ 69

DIVISION

25.	26.	27.	28.
$54 \div 9 =$	$24 \div 4 =$	$6 \div 3 =$	$36 \div 9 =$
○ 4	○ 5	○ 2	○ 4
○ 5	○ 6	○ 3	○ 6
○ 6	○ 20	○ 9	○ 27
○ 7	○ 28	○ 18	○ 45

29.	30.	31.	32.
$7\overline{)56}$	$2\overline{)14}$	$6\overline{)36}$	$1\overline{)5}$
○ 1	○ 7	○ 5	○ 1
○ 6	○ 8	○ 6	○ 3
○ 7	○ 12	○ 30	○ 4
○ 8	○ 16	○ 31	○ 5

MIXED OPERATIONS

33.	34.	35.	36.
$15 - 6 =$	$9 \times 8 =$	$6 + 8 =$	$42 \div 6 =$
○ 1	○ 17	○ 12	○ 6
○ 8	○ 63	○ 13	○ 7
○ 9	○ 72	○ 14	○ 8
○ 21	○ 89	○ 15	○ 36

37.	38.	39.	40.
3 x 7	14 - 8	$7\overline{)21}$	6 + 3
○ 4	○ 4	○ 3	○ 3
○ 10	○ 5	○ 4	○ 9
○ 21	○ 6	○ 14	○ 10
○ 24	○ 14	○ 28	○ 18

Grade 6 Mathematics Taxonomy

Knowledge:

- Recalling specific facts
- Memorization of facts, definitions, rules, procedures, and theories
- Routine manipulation

Comprehension:

- Knowledge of concepts
- Demonstrating understanding of principles and concepts
- Translating from concrete to pictorial to symbolic representations or translating in the reverse order

Application:

- Solving problems utlilizing learned skills and concepts
- Recognizing patterns and relationships
- Comparing, interpreting, and anlysing data by applying learned skills and concepts
- Solving type problems
- Dealing with activities that are routine in the sense that concepts like (but not identical to) these would have been studied
- Normally requires two steps:
    1. formulating the problem symbolically
    2. manipulating the symbolic representation according to some previously learned algorithms

Problem Solving

What is a problem?
- highest taxonomical level
- method for solution is NOT known
- answer not obvious
- appropriate to grade level

PERFORMANCE STANDARDS

Purpose of Performance Standards

The Grade 6 performance standards statements are intended to help educators develop a shared, province wide understanding of acceptable and excellent levels of achievement for Grade 6 Mathematics.

Presented on the following pages are DRAFT statements that describe what is expected of Grade 6 students who are achieving an acceptable or an excellent level of performance on independent work at the end of the Grade 6 Mathematics program. Once finalized, these statements will represent the standards of performance against which provincial and/or local levels of student achievement will be measured. By comparing actual provincial results to expected provincial performance standards, decisions can be made about whether achievement is in fact "good enough". The standards of performance inherent in these statements are derived from the goals and objectives of Grade 6 Mathematics as presented in the 1982 *Program of Studies*.

Target Group

The Grade 6 Mathematics course is intended for all students who have been determined by their teachers to be ready for the regular Grade 6 Mathematics program after having successfully completed the Grade 5 program. The standards described on page 15, inherent in the Grade 6 Mathematics course are for this target group.

Through discussions held with educators in developing the achievement tests, the expectation exists that 85 per cent of all students will meet an acceptable level of performance but only 15 per cent will achieve a level of excellence. We are interested in knowing if these standards of performance and the expectations of how many students will meet them are appropriate. Your view regarding these expectations would be appreciated.

Acceptable Level of Performance

Students who have achieved an acceptable level of performance in Grade 6 Mathematics are expected to have a somewhat narrow understanding of the conceptual and procedural knowledge that is essential to the elementary mathematics program. For example, they may know how to do routine procedures but have difficulty applying these procedures in problem situations or explaining why these procedures work. Students may be able to subtract decimals routinely but have difficulty explaining how the regrouping works using manipulatives, pictures, or words.

For their level of performance to be considered acceptable, students are expected to be reasonably proficient in their ability to use what they know to perform the mathematical operations and procedures that are fundamental to the program. Their ability to apply what they know and can do to solve both textbook and real world problems may be somewhat more limited, however, because of their narrow understanding and limited ability to use the conceptual and procedural components of the program. For example, such students generally are able to solve simple problems but have difficulty connecting concepts found in multistep problems. These students are also able to add the value of decimals and apply the calculation rules to money but have difficulty in the transfer of these concepts to word problems or real-world problems.

Level of Excellence

It is expected that students achieving a level of excellence in Grade 6 Mathematics have internalized the mathematical concepts as outlined in the mathematics curriculum. These students are expected to have an accurate and broad understanding of the conceptual and procedural knowledge that is essential to succeed in the program. In most cases, these students can easily demonstrate their mathematical knowledge and understanding in concrete, pictorial, and symbolic contexts. These students also have the confidence and ability to transfer their mathematical understanding and make the necessary connections to novel and real-life situations.

Students achieving a level of excellence have a well-developed sense of number. They have more success in estimation and they know whether or not an answer to a calculation makes sense. These students are more likely to monitor their work regularly and are more likely to be able to verbalize mathematical situations clearly, using correct technical terms. They seem to have a better sense of logic and are more successful with abstract number patterns. They are expected not to give up readily when challenged with a complex novel problem, possibly because past successes are the encouragement to persevere. This is analogous to the 'recursive cycle phenomenon' used to describe social development in Katz and Chard, 1989.

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CREDITS

Katz, L.G., and Chard, S.C. (1989), *"Engaging Children's Minds: The Project Approach."* New Jersey: Ablex Publishing Corporation